

Title. Relationship between sleep quality, depression symptoms, and blood glucose in pregnant women

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Relationship between sleep quality, depression symptoms, and blood glucose in pregnant women

Abstract

Sleep quality during pregnancy affects maternal/child health. We aimed to assess changes in sleep quality during pregnancy and determine its relationship to maternal mood, blood glucose, and work schedule among primiparous women. We conducted a prospective/longitudinal/observational study. Ninety-two pregnant women were recruited from Midwestern hospital. Mood and sleep quality data were collected using Edinburgh Postnatal Depression Scale/Pittsburgh Sleep Quality Index at gestational weeks 22 and 32. Forty-three women completed the study. Twenty-six women (63%) were African-American and the mean age was 23.64 (SD=3.82) years. Rate of poor sleep quality increased during pregnancy with 25% of women had scores indicative of depression symptoms. Poor sleep quality score was related to mood scores ($P < 0.05$) and work schedule. Blood glucose was not significantly related to sleep duration. In conclusion, poor sleep quality during pregnancy was associated with poor mood and work schedule, suggesting that interventions targeting mental health and lifestyles are needed.

Key Words: Sleep quality, pregnancy, mood/depression, gestational diabetes, work schedule

Maternal and infant health in the short and the long-term are impacted by maternal factors in the perinatal period. Maternal factors that impact morbidity and mortality include the women's mental and physical health and modifiable factors such as smoking, substance abuse, adolescent pregnancy, obesity, and nutrition (Waters, Hay, Simmonds, & Goozen, 2014; Gaillard, 2015; Raio, Bolla, & Baumann, 2015). In addition, there is growing evidence that sleep quality during pregnancy affects the mother's health, which in turn affects the infant's health.

It is recommended that adults sleep 7-8 hours per day (Watson et al., 2015; NIH, 2011), however nearly 30% of adults sleep on average of six hours or less a day (Schoenborn, 2013). Adequate sleep rates vary in US populations by race and socio-economic level. Among women, 36% of Blacks or African Americans get ≤ 6 hours of sleep each day versus 27% of Whites. Further, 33% of women below poverty versus 25% with household incomes 4-times the poverty level reported ≤ 6 hours of sleep (Schoenborn, 2013). Compared to multiparas, nulliparas generally had less efficient sleep, spent more time in bed and had greater wake after sleep onset in the second trimester (Signal et al., 2007).

Short sleep duration during pregnancy is associated with hormonal and metabolic alterations, and in the long-term is associated with development of metabolic disease (Fu et al., 2015). Pregnant women who slept less than eight hours a night were found to be at an increased risk for delivering small for gestational age infants (Rawal, Hinkle, Zhu, Albert, & Zhang, 2017). African American women with poor sleep quality (PSQI > 5) had 10.2 times the odds of preterm birth compared to those with good sleep quality (Blair, Porter, Leblebicioglu & Christian, 2015). In addition, short sleep duration and a later sleep midpoint were associated with an increased risk of gestational diabetes (odds ratio, 2.24; 95% confidence interval, 1.11-4.53; and odds ratio, 2.58; 95% confidence interval, 1.24-5.36, respectively) (Facco, et al., 2017; Izci

Balserak, Jackson, Ratcliffe, Pack, & Pien, 2013, Wang, et al., 2017). Rate of gestational diabetes mellitus was found to be higher among women sleeping less than four hours compared with those sleeping nine hours per night (Cai, et al., 2017; Wang, et al. 2017). Shorter sleep duration in the third trimester was also found to be associated with higher blood pressure, while risk for pre-eclampsia was 9.5-fold higher in very short sleepers (<5 h) versus women with adequate sleep (Williams et al., 2010; Sharma, et al., 2016).

Depression affects approximately 10–25% of women during pregnancy (Faisal-Curry & Menzes 2007). Self-reported poor sleep during pregnancy has been associated also with mood disturbance and with increased risk for future mood problem. Canadian women who had poor sleep quality during first trimester and experienced significant increases in sleep problems throughout pregnancy were also the group who reported the highest levels of anxiety and depressive symptoms throughout pregnancy (Tomfohr, Buliga, Letourneau, Campbell, Giesbrecht, 2015). Depressive symptoms were also strongly associated with insomnia during late pregnancy, especially with sleep durations <5 or >10 hours (Dørheim, Bjorvatn, Eberhard-Gran, 2012). In addition, Okun, Mancuso, Hobel, Schetter, Coussons-Read (2018) studied the relationship between sleep quality and symptoms of depression and anxiety in women during pregnancy and postpartum. They found out that poor sleep quality was significantly associated with greater symptoms of depression and anxiety. Women who had significantly higher EPDS (Edinburg Postpartum Depression Scale) scores ($\beta = .585$, $p < .001$) also had elevated total Pittsburg Sleep Quality Index (PSQI) scores after adjustment for covariates.

Life style behaviors during pregnancy such as work schedule, Internet and electronic devices use also affect sleep quality. Women who worked nights or rotating shifts during pregnancy were found to be at increased risk of miscarriage, pre-term birth, and low birth weight

infants (Stocker, Macklon, Cheong, & Bewley, 2014; van Melick, van Beukering, Mol, Frings-Dresen & Hulshof, 2014). Working consecutive night shifts and quick returns after night shifts during first/mid trimester was also associated with an increased risk of hypertensive disorders of pregnancy, particularly among obese women (Hammer et al., 2018). In addition, a systematic review with meta-analysis by Bonzini et al., (2011) studied the associations of shift **work** with preterm delivery (PTD), low birthweight (LBW), small-for-gestational-age (SGA) infants and pre-eclampsia. They observed increased relative risk for PTD, LBW and SGA. Hammer et al., (2018) also found that among night workers, the risk of Hypertensive Disorders of Pregnancy (HDP) grew with increasing number of consecutive night shifts [odds ratio (OR) 1.41, 95% confidence interval (CI) 1.01-1.98] and of quick returns after night shifts (OR 1.28, 95% CI 0.87-1.95). Among obese women, those who worked long night shifts had a 4-5 fold increased risk of HDP compared to day workers.

Although previous studies contributed to the understanding of the multifactorial nature of pregnancy-related sleep disturbance, pregnant women still suffering from poor sleep quality during pregnancy and its consequences on mother and infants. In addition, few studies considered work schedule and screen time use and its effect on sleep quality during pregnancy. The purpose of this study was to assess changes in self-reported sleep quality during pregnancy and its relationship to mood, blood glucose, development of gestational related disease (diabetes, hypertension preeclampsia) and life style behaviors in a sample of primiparous women. We hypothesized that sleep quality will decrease throughout pregnancy and poor sleep quality will be associated with increased depressive symptoms, gestational diseases, and blood glucose. In addition, work schedule and screen time use will be related to sleep quality during pregnancy.

Methods

Study Design, Sample, and Setting

Following institutional review board approval, a longitudinal observational prospective cohort study was conducted. Ninety-two primiparous women were recruited from a Midwestern affiliated prenatal clinic. Inclusion criteria were primiparity, 18-40 years of age expecting a singleton infant. Ninety-two women were recruited for the study with the assumption of a ~60% retention rate for a target of 50 women. Rationale for sample size was based on a prior power calculation. Specifically, a power of 89%, with alpha error rate set at 5%, was found for a sample size of 50. This study was a part of a longer longitudinal study that followed up participants after giving birth and collected saliva in addition to Actiwatch monitoring during pregnancy and after giving birth.

Tools, Data Collection, and Study Timeline

Based on literature review, the research team developed an intake survey to gather data on subject's, daily life behavior variables such as internet use, work schedules, and use of electronic devices and demographics such as age, education, ethnicity, race, occupation and income. Content validity of the survey was tested by a panel of five experts in the field of Obstetrics and Pediatrics and five pregnant women tested face validity. The survey was modified based on the comments. Pittsburgh Sleep Quality Index [PSQI; Cronbach's $\alpha = 0.83$ (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Carpenter & Andrykowski, 1998)] and Edinburgh Postnatal Depression Scale [EPDS; Cronbach's $\alpha = 0.87$ (Cox, Holden, & Sagovsky, 1987)], were used to measure sleep quality and symptoms of perinatal depression, respectively. The PSQI consists of 19 self-rated questions, amounting in seven component scores: sleep quality,

sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of medication to sleep, and daytime dysfunction. The sum of these scores results in total sleep quality score (ranging 0-21). A PSQI score of ≤ 5 is associated with good sleep quality, and a score of > 5 is associated with poor sleep quality. The EPDS scale used to screen for depression symptoms, and consists of ten questions each with a score rank from zero to three. A score ≥ 10 on EPDS indicates risk of depressive mood. Mothers who had score more than 10 or reported suicidal ideation were reported immediately to their obstetricians.

At the time of enrollment, consent was obtained from women to collect protected health information (PHI) from their medical records. Data collected included pre-pregnancy body mass index (BMI), blood glucose levels after 75 g glucose challenge test, illicit drug screen results and health history during pregnancy. The glucose challenge test was performed between 24-28 weeks according to the American Congress of Obstetrics and Gynecologists (ACOG). The diagnosis of Gestational Diabetes Mellitus (GDM) is made when any of the following plasma glucose values are met or exceeded: Fasting: At or above 92 mg/dL, 1 hour: At or above 180 mg/dL, 2 Hour: At or above 153 mg/dL (ACOG, 2018).

Women were enrolled at ≤ 22 weeks gestation. At time of enrollment women completed the intake survey. During gestation week 22 (G22), G32 women completed the PSQI and EPDS surveys online (Qualtrics™) or by phone.

Data and Statistical analysis

All data collected were entered and stored on a secured server (RedCap). Statistical analysis was conducted using SPSS; P -value ≤ 0.05 was considered significant. Shapiro-Wilk test used to test the normality of the data. Descriptive statistical analysis of demographic and life

style factors was performed. Wilcoxon signed-rank test was used to compare PSQI scores and EPDS scores in two different times (G22, G32). Using Mann-Whitney test, the relationship of sleep quality to EPDS score, blood glucose level, pre-pregnancy BMI and gestational related disease was analyzed, and Kruskal–Wallis one-way analysis of variance was used to explore the relationship between working statuses and sleep quality at G22.

Results

Demographics of Study Population

Of the 92 women enrolled, 43 women completed all aspects of the study throughout the three time points. Twenty-five percent ($n = 11$) of the enrolled population was withdrawn from the study by members of the research staff due to failure to comply with study protocol. Changes in health status or other life events prevented 23% ($n = 10$) of women from completing the study. The remaining women who did not complete the study as they changed their minds about participating. Analysis of recruited, retained and withdrawn populations found no difference in demographic variables among these groups (Table 1).

Women who completed all elements of the study ranged in age from 18-33 years old, with median age 23.63 (SD=3.84) years old (Table 1). Women were primarily urban dwellers (98%). Racial distribution of the population that completed study was 64% ($n = 27$) Black or African American, 18% ($n = 7$) White, and 13% ($n = 4$) more than one race (Table 1). At the time of enrollment, the vast majority of the participants (93%) indicated they had daily internet access and thus 86% completed study surveys using the online (Qualtrics™) option.

During enrollment, women were surveyed for lifestyle factors that may affect sleep quality including work schedules and use of electronic devices. The majority (58%, $n = 25$) of

employed women worked day shifts (anytime between 6AM and 6PM); the remaining worked rotating, evening or night shifts. The majority of women (61%, $n = 26$) turned off their electronic devices ≤ 15 minutes before going to bed, while 39% ($n = 17$) turned off devices more than 15 min before going to bed. Analysis of recruited, retained and withdrawn populations found no difference in demographic variables among these groups.

Other information on lifestyle factors obtained through intake survey or abstracted from medical charts included prenatal vitamin use, smoking history, illicit drug screen results, as well as rate of attendance of prenatal appointments. At the time of enrollment 91% of the women indicated that they were taking prenatal vitamins and 13% of the women responded that they had ever smoked cigarettes, with only one subject indicating she was a current smoker. Rate of illicit drug use, as determined from urine sample taken during first prenatal visit, was 11%. All women, who had tested positive, tested positive for cannabinoids, and only cannabinoids. Rate of keeping prenatal appointments made was 87% across the population, with the median number of prenatal appointments being fourteen. The median and range of number of appointments attended were 14 and 9-35 visits, with 93% of women attending >10 prenatal appointments during the course of their pregnancy.

Sleep Quality and Maternal Mood

During G22 approximately 35% ($n = 15$) of women had PSQI scores indicative of poor sleep quality (score > 5). The percent of women reporting poor sleep quality increased to 57% ($n = 25$) between G22 and G32 (Figure 1). Analysis of PSQI sub-component scores found that between G22 and G32 there was no significant difference in the distribution of total sleep time (7.58 hr and - 7.43 hr, respectively, $P = 0.209$). The percent of women reporting adequate sleep efficiency (percentage of time in bed asleep) decreased from 60% to 40% between G22 and G32

and there was a shift in rating of efficiency from somewhat poor (score 1), poor (score 2) to very poor (score 3), with 12.5 % of women scoring very poorly (score 3) at G32, (Figure 2). Based on Spearman's rho correlation test, the correlation of the across time points was calculated. There was a significant correlation for PSQI scores across time-points G22 and G32 ($\rho = 0.599$, $P < 0.001$).

During G22, EPDS scores ranged from 0-16, and median EPDS score for the population was six. Approximately 25% ($n = 11$) of women in our population had EPDS scores indicative of symptoms of potential depression (≥ 10). Although median EPDS score increased from 6 to 6.5 between G22 and G32, rate of women with potential depressive did not have a significant change ($P = 0.226$). There was no significant difference in the distribution of EPDS scores among the two time points ($P = 0.852$). Spearman correlation analysis of EPDS scores showed significant relationships between G22 and G32 ($\rho = 0.842$, $P < 0.001$).

The relationship between mood and sleep quality was also analyzed for each study time point (Figure 3). PSQI scores were correlated with EPDS during G22 ($\rho = 0.538$, $P < 0.001$) and G32 ($\rho = 0.543$, $P < 0.001$), maternal mood scores among women who rated sleep as poor quality (PSQI score > 5) versus women with good sleep quality ratings (PSQI score ≤ 5) were compared and found to be significantly different at G22 ($R = 0.272$, $P = 0.009$) and G32 ($R = 0.393$, $P < 0.001$). (Figure 3).

Sleep Quality, Body Mass Index and Blood Glucose

We analyzed whether there is a relationship between sleep quality scores and blood glucose, pre-pregnancy BMI or whether women had any diagnosis of diabetes, hypertension and/or pre-eclampsia during study. In our sample approximately 48% ($n = 21$) of the women had

healthy pre-pregnancy BMI (>18.5 , <25), 4% ($n = 2$) were underweight (BMI <18.5), 20% ($n = 9$) were overweight (BMI >25 , <30) and 28% ($n = 12$) were obese (BMI >30), based on National Institute of Health (NIH) classifications (NIH, 2000). The rate of diagnosis of gestational diabetes, pre-eclampsia and hypertension were 11%, 13%, and 27%, respectively, and 33% all three combined. Since the sample size was too small to study potential relationship of each disease with variable of interest, analysis was conducted to examine development of any gestational related disease (gestational diabetes, pre-eclampsia and/or hypertension).

There was no significant difference in blood glucose level between women categorized as having poor sleep quality (PSQI > 5) versus good quality (PSQI ≤ 5) at any time point. Blood glucose levels were compared between groups of women that reported getting >7 hours versus ≤ 7 hours of sleep each night; blood glucose levels were not significantly different between women sleeping ≤ 7 hours versus > 7 hours at G 22 ($R = 0.048$, $P = 0.652$) and G32 ($R = 0.142$, $P = 0.174$). Using Spearman's correlation test, no significant relationship was also found between BMI and PSQI score at G22 ($\rho = -0.125$, $P = 0.455$) and G32 ($\rho = 0.056$, $P = 0.729$).

Relationship between development of gestational related disease and PSQI or maternal mood score were analyzed for each time point. Mann-Whitney test found not significant difference. There was no significant relationship in development of gestational related disease and pre-pregnancy BMI (mean BMI for no disease versus disease, respectively, was 25.6 ± 6.07 and 29 ± 10.0). Spearman correlation analysis found no significant relationship among pre-pregnancy BMI and EPDS score at any time point ($P = 0.335$ for G22 and $P = 0.356$ for G32).

Sleep Quality and Lifestyle Behaviors

Several confounding factors could be related to sleep quality and mood. The relationship of sleep quality or maternal mood to life style factors was also analyzed. There was a significant difference between sleep quality scores among women with different work schedules. At G22, women who worked daytime shifts had significantly ($P = 0.036$) better sleep quality scores than those who worked evening-night or rotating shifts. Interestingly, women who were out-of-work had the widest variability in sleep quality scores, and due to this variability mean PSQI score was not different from either day-time or shift/night workers (Figure 4). We also found women with screen time >15 mins have significantly lower (-0.554) PSQI score than women with screen time <15 mins ($P = 0.011$). However, no significant difference ($P=0.1$) in PSQI score between women who turned off electronic devices >15 minutes versus ≤ 15 min before bed (Figure 5).

Discussion

The purpose of this study was to assess the changes in self-reported sleep quality during pregnancy and its relationship to mood, blood glucose, development of gestational related disease and life style behaviors in a sample of primiparous women. We found that the proportion of women having scores indicative of poor sleep quality increased from early to late pregnancy. The changes in self-reported sleep quality between G22 and G32 were characterized primarily by a decrease in sleep efficiency. These results is consistent with previous studies and a recent meta-analysis (Naud, Ouellet, Brown, Pasquier, & Moutquin, 2010; Sivertsen, Hysing, Dørheim, & Eberhard-Gran, 2015; Sedov, Cameron, Madigan, & Tomfohr-Madsen, 2018). Yang et al. (2018) also found that eighty-seven percent of pregnant women experienced sleep disorder (PSQI score >5). Poorer global sleep quality, subjective sleep quality, lower sleep efficiency and sleep disturbances were most prevalent during third trimester. Since over 60% of our sample were African American women who were at high-risk population. Our results were also

consistent with Amyx, Xiong, Xie, and Buekenes (2017) who reported shorter sleep duration among minority women compared to white. Despite reporting less adequate sleep, minority women are less likely to report trouble sleeping, which provides evidence of an important health disparity that may need to be considered when overseeing the care of this high-risk women. Changes in sleep efficiency during pregnancy compared to non-pregnancy were found to be related to sleep disturbances due to urinary frequency, back or hip ache, and heartburn (Reichner, 2015).

The rate of 25% of women in our study having scores indicative of depression symptoms during pregnancy is higher than the overall rate reported in a 2012 Cochrane systematic review, which found depression during pregnancy has a prevalence of 18.4% across the nine months (Dennis, 2013). Women are vulnerable to mood disturbances during the perinatal period (Bei, Coo, Trinder, 2015). Causes of perinatal depression are not fully understood, but are thought to be due in part to interactions among physiological changes (e.g. dramatic hormonal changes) and psychosocial factors (e.g. antenatal anxiety and depressive symptoms, the presence of psychiatric history, marital conflict, lack of social support, and stressful life events) (Bei, et al., 2015). Moreover, reduced quantity of sleep is associated with difficulties in coping with stressful life events (Baglioni, Spiegelhalder, Lombardob, & Riemanna, 2010). Poor sleep quality is considered comorbid to depression, with multiple prospective longitudinal studies reporting poor sleep as risk factors for major depression (Baglioni, et al., 2010). Thus, the association between PSQI and EPDS scores found at G22 and G32 was similar to previous report (Skouteris, Wertheim, Germano, Paxton, & Milgrom, 2009; Yu et al., 2017).

Although in our study there was no significant association of poor sleep quality with higher blood glucose and development of gestation related diseases was found. Larger cohort

studies have found much stronger relationships among poor sleep quality during pregnancy and high blood glucose levels as well as development of gestational diseases to include hypertension, preeclampsia and diabetes (Izci Balserak et al., 2013; Qiu et al., 2010; Williams et al., 2010). Herring et al. (2014) also found that shorter nighttime sleep was associated with hyperglycemia, even after controlling for age and body mass index among pregnant women.

At G22, sleep quality was significantly associated with work schedule and status. Women who worked daytime shifts had better sleep quality scores than those who worked night or rotating shifts. According to (Voinescu, 2018), workers in rotating shifts, reported increased sleepiness, poorer sleep quality, and shorter sleep duration. In our study, women who were out-of-work in our study had the widest variability in sleep quality scores. ‘Social jetlag’ likely accounts for poorer sleep quality among night-rotating shift workers, and is the discrepancy that arises between circadian and social clocks that results in chronic sleep loss (Roenneberg, Allebrandt, Merrow, & Vetter, 2012). In particular, social jetlag occurs in individuals when they travel back and forth between time zones on workdays (socially imposed schedules) and free (non-work) days, and is associated with development of metabolic risk factors that predispose to diabetes and cardiovascular disease (Wong, Hasler, Kamarck, Muldoon, & Manuck, 2015). The variation in sleep quality among women who were out of work may be due psychosocial factors (e.g. antenatal anxiety and depressive symptoms, marital conflict, lack of social support, and stressful life events) or behaviors that interfere with good sleep. Although we didn’t find significant difference in PSQI score between women who turned off electronic devices >15 minutes versus ≤ 15 min before bed, a systematic review of screen-time use and sleep quality in school aged children found a screen time is adversely associated with sleep outcomes (primarily

shortened duration and delayed timing) in 90% of studies (Hale & Guan, 2015). We could not find data related to screen use during pregnancy.

Our results confirm and highlight the need for interventions that enhance and restore sleep quality and efficiency during pregnancy with special focus on mental health and life style modifications that could improve maternal/child outcomes. This study need to be replicated in larger sample size using objective data collection methods in addition to the subjective measure. More studies are also need that address understating the biobehavioral factors related to sleep quality and disturbance such as using cortisol and inflammation biomarker to assess the effect of sleep and stress on pregnancy out comes.

There are several limitations to the study. Although the aim was to have 50 participants complete study, the withdraw rate (55%) was higher than expected (45%) and likely due to the nature of the longitudinal study. Another limitation was the women self-reported their sleep quality/efficiency and symptoms of depression; however the tools were validated and found reliable indicators of sleep and mood in multiple previous studies.

Sleep quality during pregnancy was found to be associated with maternal mood in the prenatal period. No significant association of poor sleep quality with higher blood glucose and development of gestation related disease was found. Life style behaviors such as work schedule, was found to be related to sleep quality and maternal mood. These results highlight the importance of interventions that address sleep enhancement and restoration.

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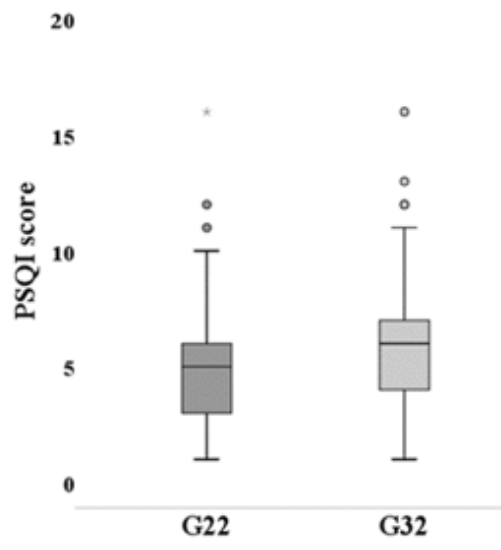
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Figure 1: PSQI scores of subjects at gestation week 22 (G22) and 32 (G32)



The sum of PSQI scores ranged between 0 to 21. A PSQI score of ≤ 5 is associated with good sleep quality, and a score of > 5 is associated with poor sleep quality.

Figure 2: Percentage of sleep efficiency scores at gestational weeks 22 (G22) and 32 (G32)

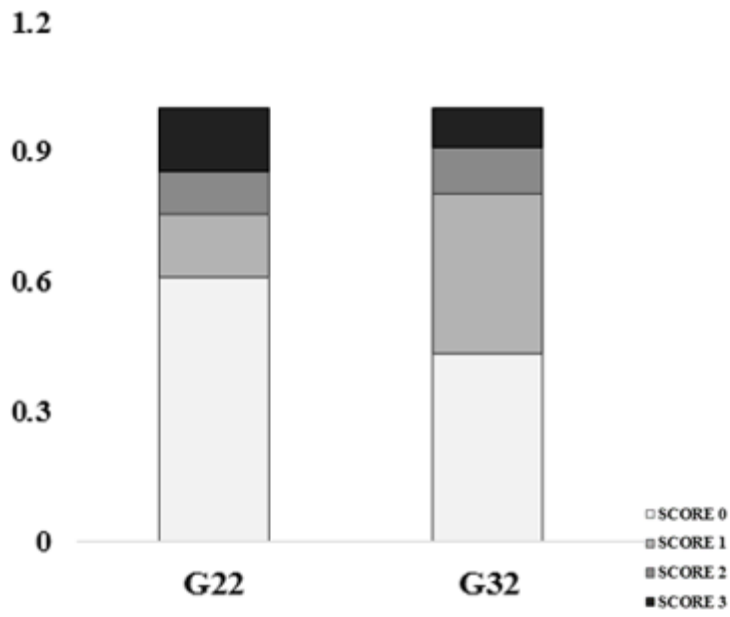


Figure 3: Maternal mood scores (EPDS) among women with PSQI scores indicative of good (≤ 5) and poor (> 5) sleep quality during pregnancy

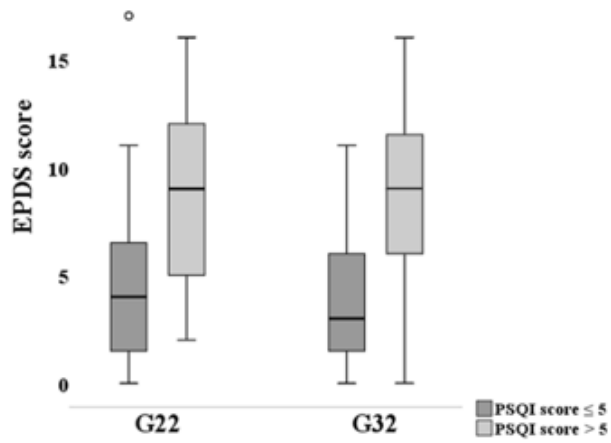


Figure 4: Impact of work schedule status on sleep quality at gestational week 22

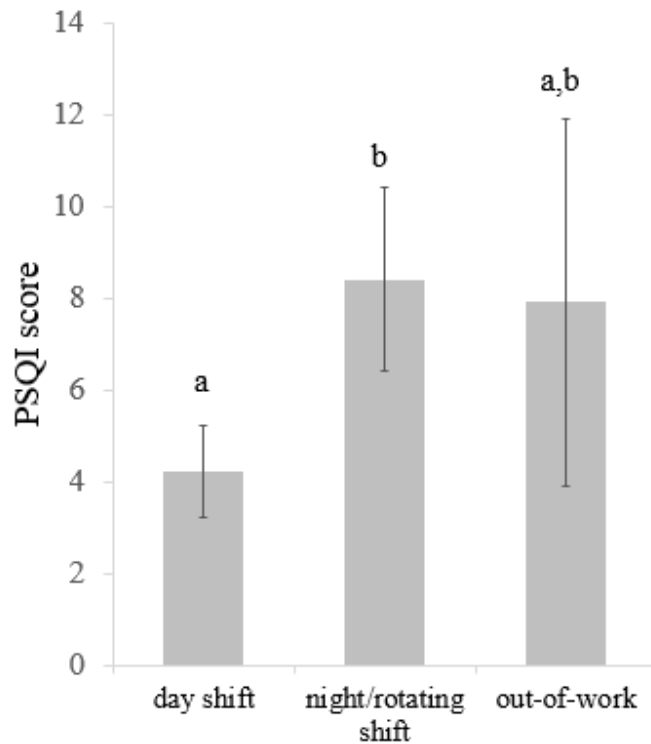


Figure 4: Analysis of the impact of work-schedule/work status on sleep quality at G22 found a significant difference in PSQI scores between day-shift and night/rotating shift workers, but no difference between women-out of work and day or night/rotating shift workers. Different letters indicate a difference at $P < 0.05$.

Figure 5: Impact of screen time during pregnancy on sleep quality at gestational week 22

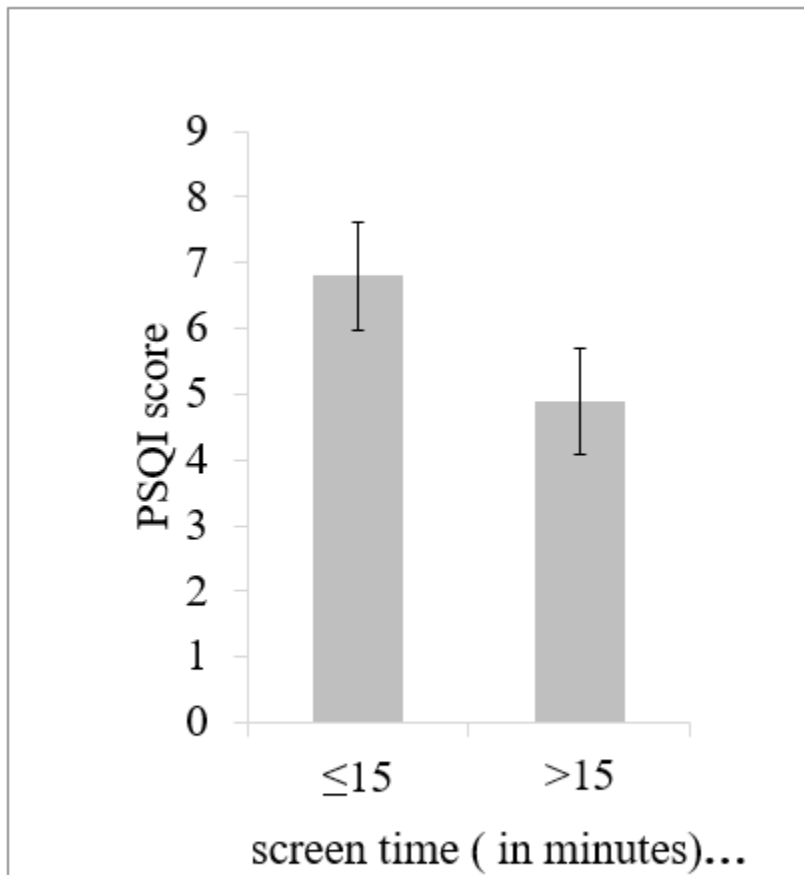


Figure 5: Analysis of the impact of screen time on sleep quality during gestational week 22 (G22), found no significant difference ($P=0.1$) in PSQI score between women who turned off electronic devices >15 minutes versus ≤15 min before bed.

Table 1. Demographics of recruited and retained women for all aspects of longitudinal study

	Recruited N=92	Retained n=43	Difference between recruited and retained
	No. (%)	No. (%)	P-value*
Race			
Asian	1 (1.1)	1 (2.4)	0.2660
Black or African American	54 (58.7)	27 (64)	0.4105
White	23 (25.0)	7 (18)	0.2756
More than one race	12 (13.0)	5 (13)	0.4040
Unknown/not reported	3 (2.2)	3 (5)	0.1100
Education			
Less than 7th grade	2 (2.2)	1 (2.3)	0.9212
Junior High (9th grade)	1 (1.1)	1 (2.3)	0.2763
Partial High School (10th or 11th grade)	8 (8.7)	0 (0.0)	0.0079
High School Graduate or GED	58 (63.0)	27 (62.8)	0.8445
Associate degree (2 years)	7 (7.6)	3 (7.0)	0.8845
Bachelor's degree (4 years)	8 (8.7)	5 (11.6)	0.3283
Graduate Degree	8 (8.7)	6 (14.0)	0.0826
Yearly household income			
Less than \$10,000	43 (46.7)	19 (44.2)	0.7814
\$10,000-\$24,999	21 (22.8)	9 (20.9)	0.7660
\$25,000-\$49,999	19 (20.7)	9 (20.9)	0.8773
\$50,000-\$74,999	3 (3.3)	2 (4.7)	0.4648
Greater than \$74,999	4 (4.3)	2 (4.7)	0.8502
Work status			
Homemaker	4 (4.3)	4 (9.3)	0.0261
Out of work, NOT looking for work	5 (5.4)	3 (7.0)	0.5088
Out of work and looking for work	21 (22.8)	8 (18.6)	0.4303
Self-employed	1 (1.1)	1 (2.3)	0.2763
Working for wages	60 (65.2)	27 (62.8)	0.8505

* Two sample proportion z-test was used to analyze differences between recruited and retained population of women.

Table 2. Linear regression analysis of the relationship of the PSQI and EDPS scores across time points and inter-survey scores within time point

Regression analysis of PSQI score across study time-points

Analysis across time point G22 to G32

Pearson correlation coefficient (R) 0.643

P-value <0.001

Regression analysis of EDPS score across study time-points

Analysis across time point G22 to G32

Pearson correlation coefficient (R) 0.804

P-value <0.001

Regression analysis PSQI to EDPS score within study time-point

Analysis within time point G22 G32

Pearson correlation coefficient (R) 0.506 0.574

P-value <0.001 <0.001